7. WBS Dictionary

The NOνA Work Breakdown Structure (WBS) defines the total set of items to be developed and produced in order to accomplish the scientific goals set out in Chapter 3. The breakdown at Level 2 is shown in Table 7.1.

WBS elements at Level 2		Task Name
R&D	Construction	
1.0	2.0	Accelerator and NuMI Upgrades
1.1	2.1	Site and Building
1.2	2.2	Liquid Scintillator
1.3	2.3	Wavelength Shifting Fiber
1.4	2.4	PVC Extrusions
1.5	2.5	PVC Modules
1.6	2.6	Electronics Production
1.7	2.7	Data Acquisition Systems
1.8	2.8	Near Detector Assembly
	2.9	Far Detector Assembly
1.9	2.10	Project Management

Table 7.1 NOνA Level 2 WBS tasks. 1.x are the R&D tasks and 2.x are the construction project tasks.

7.1 Construction WBS Dictionary at Levels 2 and 3

This section is under construction.

7.2 R&D and Operating WBS Dictionary at Levels 2 and 3

This section defines the WBS tasks for a NOνA R&D Project through Level 3. WBS 1.0 is for the research and development of the NOνA Near and Far Detectors and the Far Detector Hall. NOνA design and construction is covered in WBS 2.0 and that dictionary is in Chapter 6

WBS 1.0 **Accelerator and NuMI Upgrades**

This section is under construction.

WBS 1.1 **Site and Building**

This Level 2 element covers the design, planning and value management for the far detector hall as well as the site evaluation and environmental assessment.

WBS 1.1.1 Site Conditions Investigation:

This WBS element includes the investigations required to provide a comprehensive understanding of the conditions at the far detector site. This is a necessary prerequisite for designing the far detector hall.

WBS 1.1.2 Title 1 Preparation:
This WBS element provides for preparation of Title 1 documents for the far detector hall.

WBS 1.1.3 Site Logistics:
This WBS element consists of an investigation of the site support activities that will be necessary during the construction phase of the project.

WBS 1.1.4 Management R&D Phase:
This WBS element includes the management required for planning, controlling and reporting efforts for WBS 1.1. This includes the identification and execution of value management task as well as appropriate external reviews.

WBS 1.2 Liquid Scintillator R&D

This level 2 summary element covers the development and documentation of requirements for the liquid scintillator required for both the near and far detectors. This includes various studies, simulations and measurements required to define these requirements.

WBS 1.2.1 Requirements:
This WBS element provides for development of a document detailing the experimental requirements for the liquid scintillator.

WBS 1.2.2 Scintillator Composition Studies:
This WBS element provides for scintillator composition studies. These include various light yield studies, optimization of component concentrations and simulations and measurements of attenuation length.

WBS 1.2.3 Accelerated Aging Studies:
This WBS task provides for accelerated studies of aging that results from the interaction of scintillator with various components and materials used in the detector.

WBS 1.2.4 Scintillator Production Method Studies:
This WBS element provides for development of the plan for blending of liquid scintillator.

WBS 1.2.5 Development of QC Methods:
This WBS element includes the tasks required to develop methods, procedures and plans for reliable and accurate QC testing procedures for the individual liquid scintillator components and the blended liquid scintillator.

WBS 1.2.6 Scintillator Transportation Studies:
This WBS element includes the tasks required to develop methods, procedures and plans for delivering the liquid scintillator components to the blending site and for delivering the blended scintillator to the detector sites.

WBS 1.2.7 Blending Investigations:
This WBS element includes the tasks required to develop, assess, and verify the ability of vendors to produce and QC liquid scintillator to meet our specifications.

WBS 1.2.8 Component Acquisition Investigations:
This WBS element includes the tasks required to investigate the options available for acquiring the various components required to blend liquid scintillator.

WBS 1.2.9 Integration Prototype Detector Scintillator Production:
This WBS element includes the tasks necessary to blend liquid scintillator at Fermilab for the integration prototype near detector.

WBS 1.2.10 Production Scintillator Specifications:
This WBS element provides for development of the technical specifications documents for production quantities of liquid scintillator.

WBS 1.2.11 Management R&D Phase:
This WBS includes the tasks required to support and manage WBS 1.2 activities including subproject activities and management for the liquid scintillator R&D phase.

WBS 1.3 Wavelength Shifting Fiber R&D

This level 2 summary element covers the development and documentation of the requirements for procurement, QA and shipping of the wavelength shifting fiber.

WBS 1.3.1 Requirements:
This WBS element provides for development of a document detailing the experimental requirements for the wavelength shifting fiber.

WBS 1.3.2 Vendor Investigations:
This WBS element includes the tasks required to develop, assess, and verify the ability of vendors to produce and QC wavelength shifting fiber to meet our specifications.

WBS 1.3.3 WLS Fiber Optimization Studies:
This WBS task provides for studies of wavelength shifting fiber to optimize the performance for our specific application.

WBS 1.3.4 Development of QA Methods:

This WBS element provides for development of the methods and procedures for QA testing of the wavelength shifting fiber.

WBS 1.3.5 Integration Prototype Detector Fiber Production:
This WBS element provides for delivery and QA of fiber for the integration prototype near detector.

WBS 1.3.6 Production WLS Fiber Specification:
This WBS element includes the tasks required to produce the technical specification documents for procurement of production quantities of wavelength shifting fiber.

WBS 1.3.7 Management R&D Phase:
This WBS includes the tasks required to support and manage WBS 1.3 activities including subproject activities and management for the wavelength shifting fiber R&D phase.

WBS 1.4 PVC Extrusions R&D

This level 2 summary element includes studies of various PVC materials and their properties, production of prototype extrusions as well as the development and documentation of QA and shipping plans for the PVC extrusions.

WBS 1.4.1 Physical Properties Determination and Test Method Development:
This WBS element includes measuring the optical and mechanical properties of various PVC compounds and extrusions.

WBS 1.4.2 Raw Materials:
This WBS element includes the studies required to select an appropriate PVC blend for prototype extrusion production.

WBS 1.4.3 Extrusions:
This WBS element identifies venders capable of producing extrusions to meet the NOvA specifications and produces extrusions for the Integration Prototype Near Detector. The task will also develop methods for assuring the quality of extruded products.

WBS 1.4.4 Shipping & Handling:
This WBS element includes tasks to develop a shipping and handling plan for delivery of extrusions.

WBS 1.4.5 Quality Assurance Hardware Modifications:
This WBS element provides for the modification of prototype QA hardware to be used for QA of preproduction extrusions.

WBS 1.4.6 Management R&D Phase:
This WBS includes the tasks required to support and manage WBS 1.4 activities including subproject activities and management for the PVC extrusion R&D phase.

WBS 1.5 PVC Modules R&D

This level 2 summary element provides for development and documentation of the procedures for assembly of the PVC modules and the design of the fiber manifolds, end seals and the various machines and fixtures necessary for module construction. Development of QA and shipping plans is also included.

WBS 1.5.1 Requirements:
This WBS element provides for development of requirements documents for module assembly, manifolds and end seals. QA requirements for the completed modules are also included.

WBS 1.5.2 End Seal R&D:
This WBS element includes the design and development of the manifolds and end seals as well as specification of QA procedures.

WBS 1.5.3 Photo Detector Interface R&D:
This WBS element includes the design and development of the photodetector interface as well specification of QA procedures.

WBS 1.5.4 Module Factory R&D:
This WBS element includes the development of assembly methods for the PVC modules as well as the design of machines, tooling and moving fixtures.

WBS 1.5.5 Quality Assurance and Quality Control Methods Development:
This WBS task provides for the development of a QA plan for PVC module production. Construction of the required testing equipment is also included.

WBS 1.5.6 Module Shipping and Storage R&D:
This WBS element provides for the development of a plan for shipping and handling of extrusion modules between factory sites and to the Detector sites and for managing the equipment necessary for shipping and handling.

WBS 1.5.7 Integration Prototype Detector Modules:
This WBS element provides for production of the PVC modules for the integration near detector prototype.

WBS 1.5.8 Initial Production Module Specifications:
This WBS element provides for the development of the initial production module specifications.

WBS 1.5.9 Initial Factory Tooling Specifications:
This WBS element provides for the development of the initial factory tooling specifications.

WBS 1.5.10 Management R&D Phase:

This WBS includes the tasks required to support and manage WBS 1.5 activities including subproject activities and management for the PVC module R&D phase.

WBS 1.6 Electronics R&D

This level 2 summary element includes the design, development and testing of the front end electronics and infrastructure.

WBS 1.6.1 APD Modules:
This WBS element includes development and procurement of prototype APD chips, APD carrier boards, TE coolers, optical connectors and the associated hardware that comprise the APD modules. Development of specifications for fiber alignment, power consumption, cooling and QA are also included. APD modules for the Integration Prototype Near Detector are included here.

WBS 1.6.2 Front End Board:
This WBS element includes design of the front-end boards as well as the development of testing and installation procedures. Front-end boards for the Integration Prototype Near Detector are included here.

WBS 1.6.3 Power Distribution:
This WBS element includes the design and specification of the low voltage, high voltage, cooling and power distribution for the NOνA electronics. Power distribution for the Integration Prototype Near Detector is included here.

WBS 1.6.4 Management R&D Phase:
This WBS element includes the tasks required to support and manage WBS 1.6 management activities for the Electronics subproject during R&D phase.

WBS 1.7 DAQ System R&D

This level 2 summary element includes the development of specifications and design of the hardware and software necessary to acquire and record data to archival storage and to control and monitor both the Near and Far Detectors.

WBS 1.7.1 DAQ Software:
This WBS element includes the development of specifications and the design of the DAQ software.

WBS 1.7.2 DAQ Hardware:
This WBS element includes the development of specifications and the design of hardware for receiving signals from the FEBs, buffering and archival of data and distribution of clock/timing signals.

WBS 1.7.3 Integration:
This WBS element includes the development of specifications and requirements for integration of the DAQ hardware and software.

WBS 1.7.4 Detector Control Systems:
This WBS element includes the development of specifications and requirements for the detector control system.

WBS 1.7.5 Management R&D:
This WBS element includes the tasks required to support and manage WBS 1.7 management activities for the DAQ System R&D phase.

WBS 1.8 Detector Assembly R&D

This level 2 summary includes R&D work to validate and optimize the mechanical designs and installation procedures for the NOvA Near and Far Detectors. This includes structural engineering calculations of the fully and partially assembled detectors, the mechanical design and prototyping of detector assembly mechanical systems and tooling, and the construction and testing of prototypes of both Near and Far Detectors.

WBS 1.8.1 Plane Assembly Adhesives R&D:
This WBS element includes the tasks required to choose an adhesive that is suitable for bonding the extrusion modules together for the Far and Near detector.

WBS 1.8.2 Structural Design and Validation:
This WBS element includes the tasks required to develop and optimize the structural design of the far detector.

WBS 1.8.3 Liquid Scintillator Filling and Handling R&D:
This WBS element includes the tasks required to develop techniques and semi-automatic equipment for filling the Integration Prototype, Near and Far detectors.

WBS 1.8.4 Near Detector Assembly R&D:
This WBS element includes the tasks required to develop the procedures, equipment and assembly plan for the near detector. The task also includes the design of an assembly facility and associated procedures and equipment for assembling extrusion modules. Finally, this task will design the steel-plate muon-catcher segment of the near detector, along with associated support structures and assembly equipment.

WBS 1.8.5 Integration Prototype Near Detector:
This WBS element includes the tasks required to design, fabricate and install the Integration prototype Near Detector.

WBS 1.8.6 Far Detector Assembly Engineering:
This WBS element includes the tasks required to specify and design the equipment needed to assemble and install the far detector.

WBS 1.8.7 Far Detector Installation Procedures:
This WBS element includes the tasks required to develop the far detector installation procedures, schedules and labor requirements.

WBS 1.8.8 Far Detector Prototypes:
This WBS element includes the tasks required to test and optimize the procedures and equipment designs developed under other WBS 1.8 far detector tasks. This task will lead to the final optimization of the designs of assembly tooling and materials handling equipment.

WBS 1.8.9 Management R&D Phase:
This WBS element includes the tasks required to support and manage WBS 1.8 activities for the Detector Assembly R&D phase.

WBS 1.9 Project Management R&D

This Level 2 summary element provides for internal project reviews, report preparation, site visits, local supervision, standards preparation, tracking and analysis, schedule preparation tracking and analysis and change control. It also includes procurement of relevant software and computers, the cost of running the project office and the salaries of non-scientists working on the project.